The Operational Evaluation of the Navy's Globally Relocatable Tide Model (PCTides)

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Outline

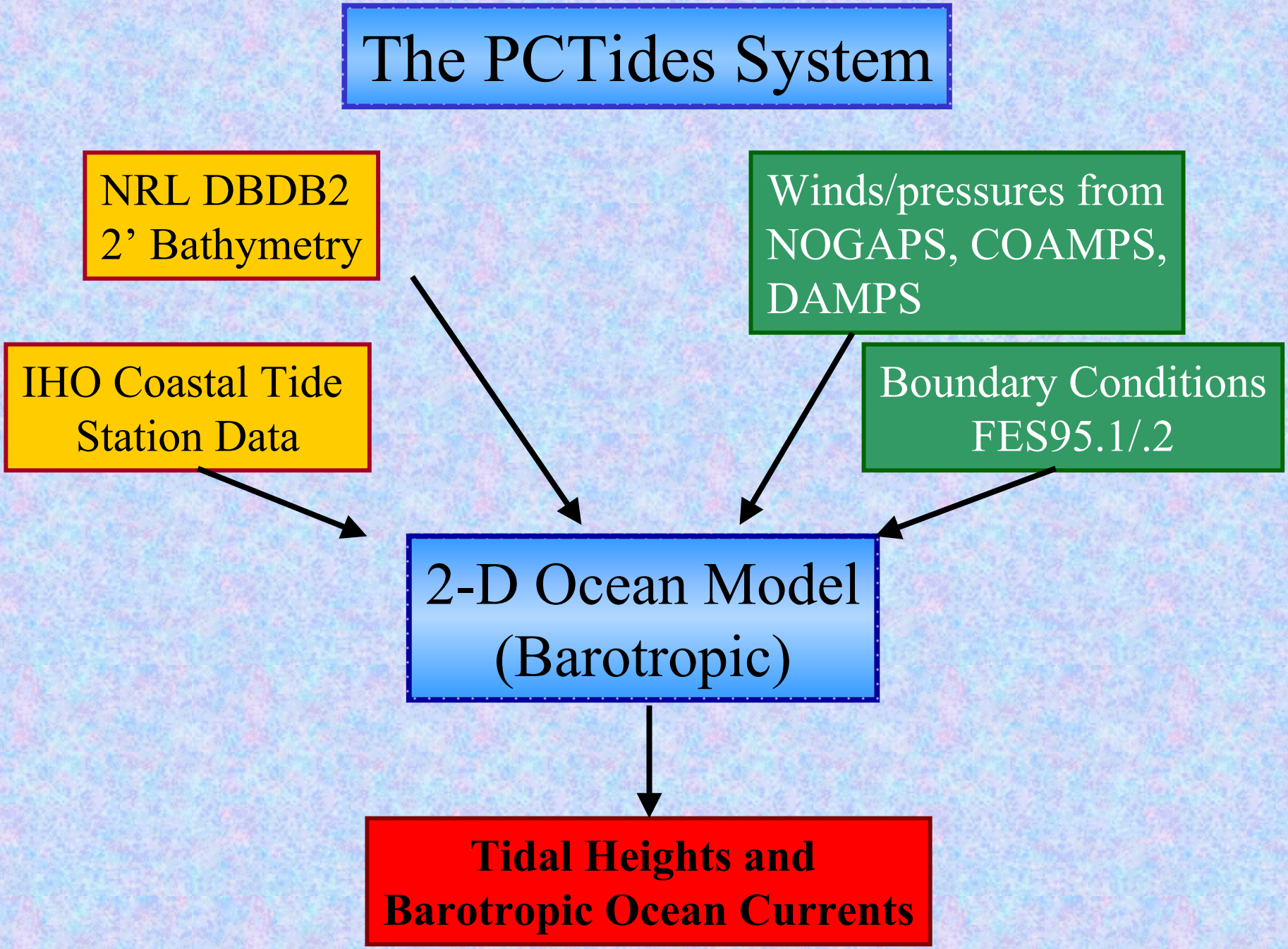
- Project History
- System Description
- System Evaluation

History

- The U.S.Navy has a requirement for global tide prediction.
- NRL developed a globally relocatable tide prediction system.
- This system runs on both UNIX and PC platforms and is called PCTides
- PCTides consists of a numerical model and global data bases such that it may be run as a “self-contained” system (no external information required unless wind forcing is used).

PCTides Description

- The core of PCTides is a 2-D barotropic ocean model.
- Data bases internal to the system are: bathymetry, boundary/initial conditions and assimilation data
- Wind forcing is the only external data
- PCTides forecasts tidal elevations, storm surge and barotropic ocean currents.


The PCTides System
NRL DBDB2
2' Bathymetry
Winds/pressures from
NOGAPS, COAMPS,
DAMPS
IHO Coastal Tide
Station Data
Boundary Conditions
FES95.1/.2
2-D Ocean Model
(Barotropic)
Tidal Heights and
Barotropic Ocean Currents

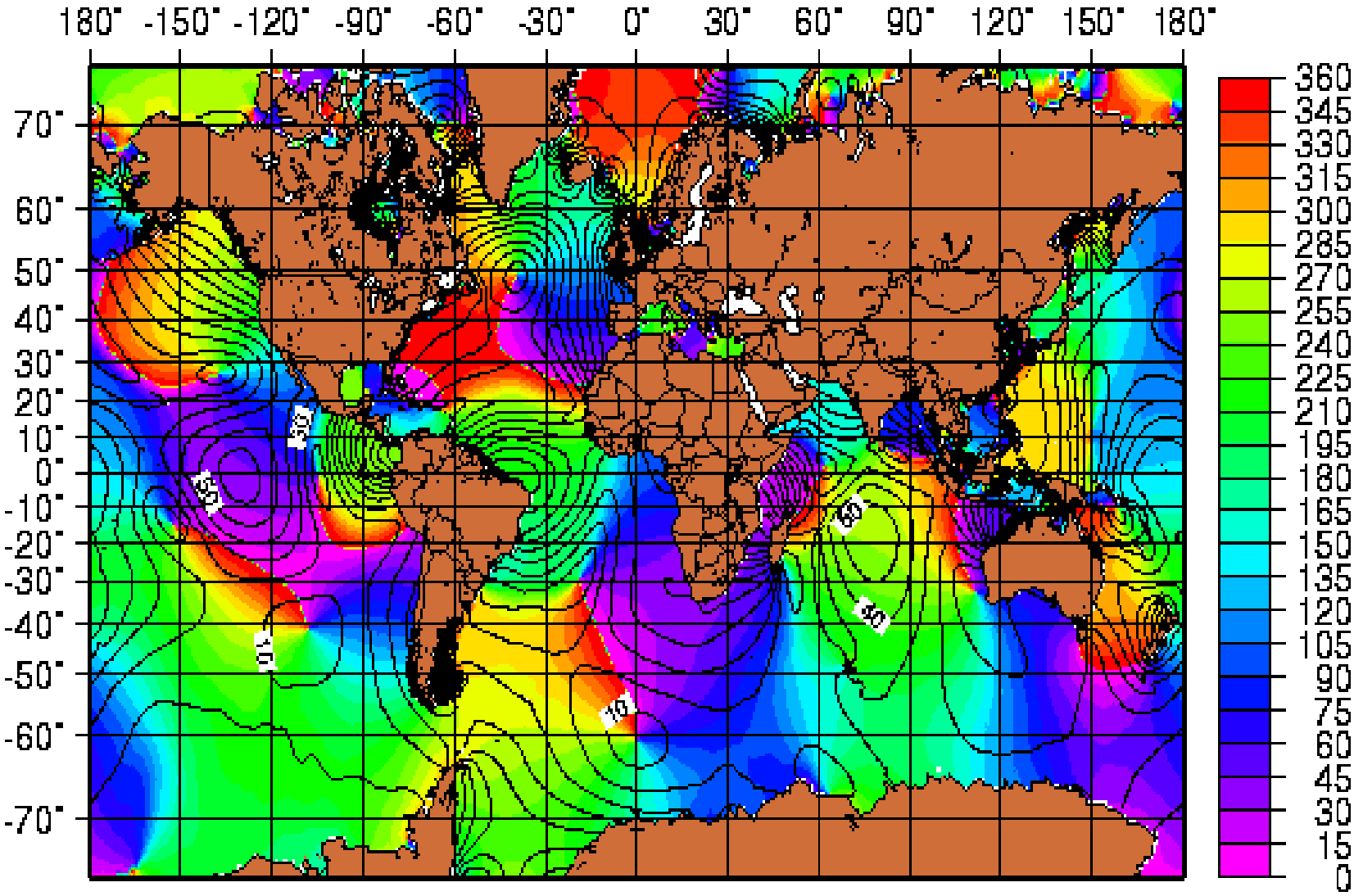
Input Data

- NRL-DBDB2 - 2 min bathymetry data
  - Composed of DBDBV, ETOPO5, DAMEE (2.5 min), GOM 0.1 deg, Choi (YES-1 min), Sandwell (GTOPO2 - 2 Min), IBCAO (Arctic-2.5 min).
  - Different data sources are smoothly blended.
  - Careful matching with World Vector Shoreline.
- IHO coastal station data: ~4500 global coastal station constituents for assimilation

Forcing

- Winds and surface pressures may be obtained from Navy products:
  - NOGAPS,
  - COAMPS or
  - DAMPS
- Boundary/initial conditions are from the Global Model FES95.1/2

Grenoble Model Adjusted M2 Tide: Amplitude and Phase



PCTides Operation

- GUI based grid generator or manual definition of grid - allows set up of a grid and interpolation of bathymetry to that grid (PC/T)
- Tidal boundary conditions placed on the grid (C)
- Stations selected for time series output (T)
- Model parameters set: starting time of run, length of run, data assimilation, winds, frequency of output (T)
- Run model (C)

Model Output

- Time series of tidal height deviation from some datum (e.g. MSL) for preselected locations
- Output at frequencies of 10-15 minutes for preselected stations
- Gridded output at a maximum frequency of 30 minutes.
- Barotropic tidal currents

PCTides OPTEST

- Prior to operational use, a model must successfully pass an operational evaluation called an “OPTEST”.
- PCTides was installed at the Navy’s regional METOC centers in Norfolk (NLMOC) and in San Diego (NPMOC).
- The PCTides OPTEST was conducted by these two centers.

OPTEST Domains

- The following PCTides gridded domains were setup and run for a 3 month OPTEST
  - the US East Coast, Chesapeake Bay region
  - the southern California Coast,
  - the Gulf of Alaska and
  - the Washington State/British Columbia waterways.

OPTEST Forecasts

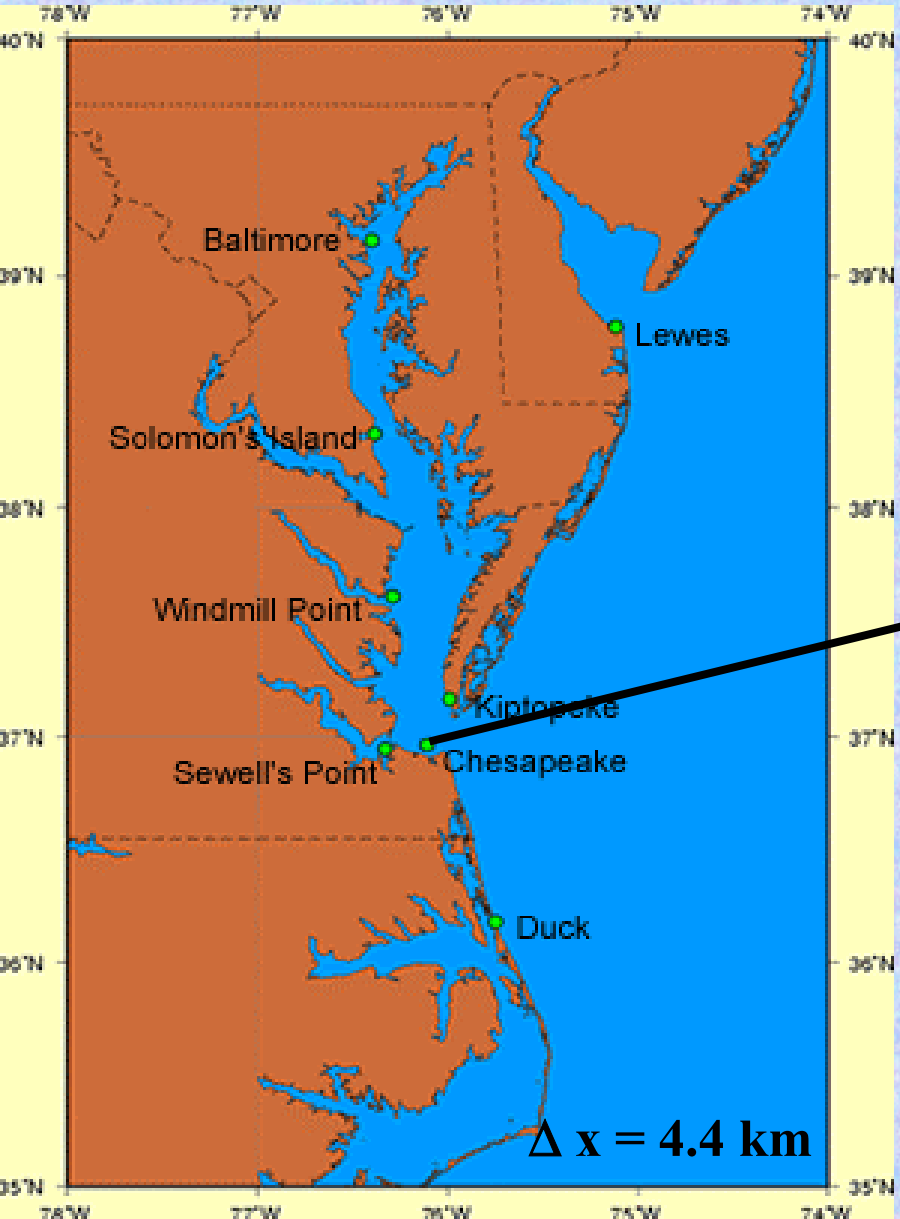
- A daily, 48-hour forecast was made for each domain.
- Forecasts used atmospheric forcing (winds and pressure fields) obtained through Metcast.
- One or more stations were pre-selected in each domain for comparison with observations.
- The daily, 48-hour forecast at each station was saved over the 3 month OPTEST.

PCTides Validation Criteria

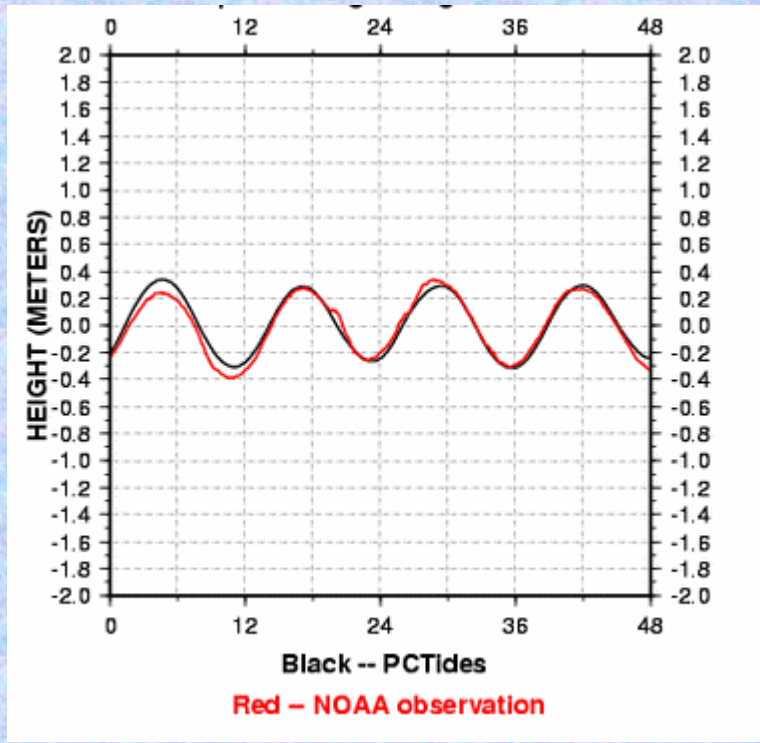
- PCTides station output was validated against NOAA sea-level height observations.

- The evaluation criteria were:
  - tidal amplitude error less than 1.2 feet (0.365 meters)
  - tidal phase error less than 45 minutes

NLMOC OPTEST Region



Chesapeake Station
July 11-13, 2001



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che
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 DATA FROM THE REGIONAL OCEAN MODEL
   DATE   TIME  HEIGHT SPEED DIREC
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 20010713   12 -0.225  0.199 121.4
 20010713   24 -0.222  0.192 123.1
 20010713   36 -0.217  0.183 125.0
 20010713   48 -0.210  0.170 126.9
 20010713  100 -0.202  0.156 129.2
 20010713  112 -0.193  0.141 131.9
 20010713  124 -0.181  0.123 135.6
 20010713  136 -0.166  0.104 140.6
 20010713  148 -0.149  0.085 148.2
 20010713  200 -0.128  0.065 161.1
 20010713  212 -0.106  0.050 184.9
 20010713  224 -0.082  0.048 220.3
 20010713  236 -0.055  0.064 248.8
 20010713  248 -0.029  0.087 264.8
 20010713  300 -0.005  0.112 274.0
 20010713  312  0.019  0.136 280.6
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 20010713  536  0.184  0.296 304.9
 20010713  548  0.185  0.292 306.3
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Done My Computer

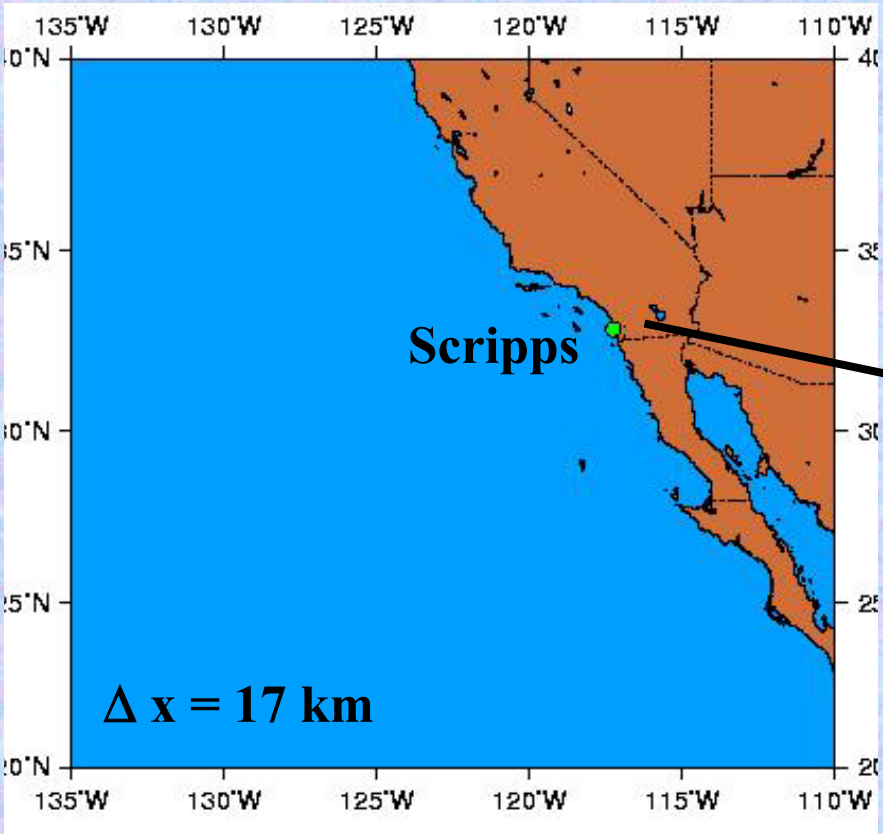
Table 1. First 24-hour forecast comparison PCTides vs NOAA Observations

Station	AME (m)	MPD (min)	RMSA (m)	RMSP (min)
Baltimore	0.28	-31.6	0.32	59.4
Solomon Island	0.10	-40.8	0.14	53.8
Windmill Point	0.08	68.6	0.11	69.2
Sewell's Point	0.09	20.1	0.12	20.8
Chesapeake	0.09	-12.4	0.12	23.7
Kiptopeke	0.09	-5.90	0.12	18.2
Lewes	0.21	2.40	0.24	14.4
Duck	0.10	-9.8	0.13	20.5

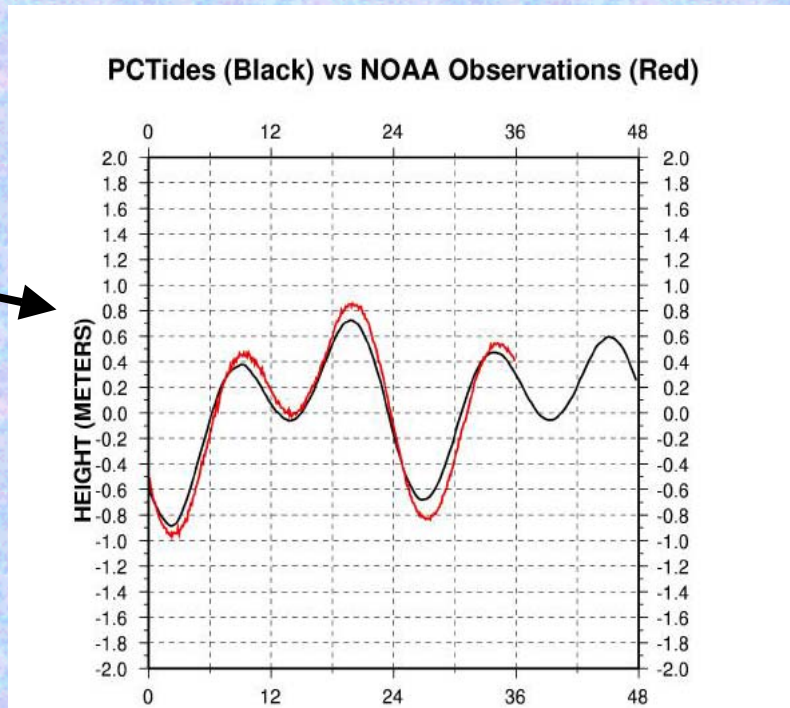
U.S. East Coast Evaluation

- In 6 of the 8 pre-selected stations, the model's RMS amplitude error was < 15 cm.
- The other 2 station's RMS amplitude error was < 33 cm.
- 5 of the 8 modeled stations had RMS phase errors < 24 minutes
- The 3 stations with larger phase errors were located in the northern part of the Bay.
- **OVERALL – phase and amplitude in 5 out of 8 stations passed criteria**

NPMOC OPTEST Region

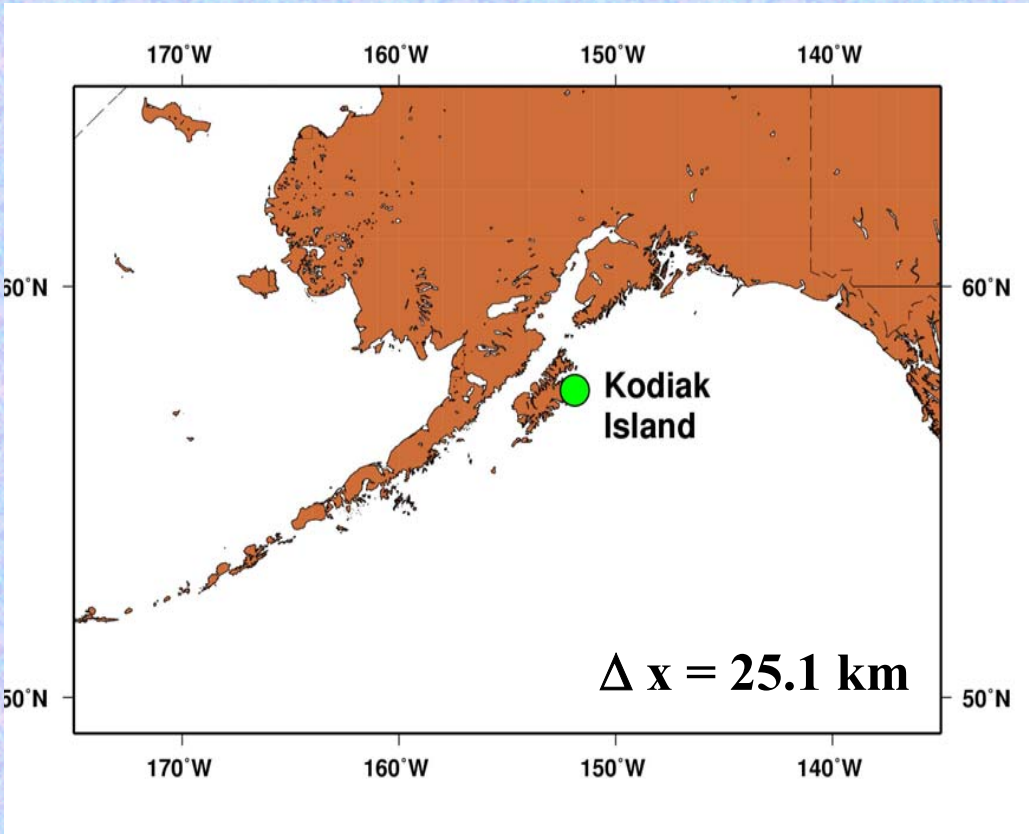


Scripps Station
June 25 - 26, 2001



NPMOC OPTEST Regions

Gulf of Alaska



Puget Sound

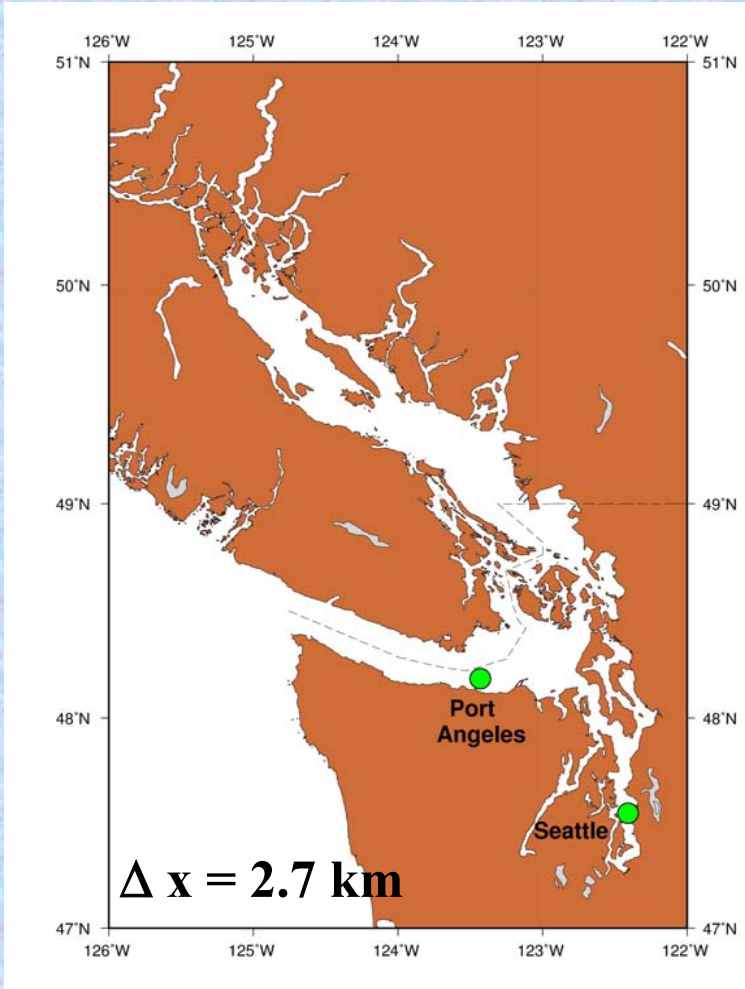


Table 2. First 24-hour forecast comparison PCTides vs NOAA Observations

Station	AME (m)	MPD (min)	RMSA (m)	RMSP (min)
Scripps	0.10	0.65	0.12	24.28
Kodiak Island	0.22	26.05	0.26	32.62
Port Angles	0.25	-7.73	0.32	25.52
Seattle	0.15	-29.83	0.18	31.09

U.S. West Coast Evaluation

- The modeled RMS amplitude error of all 4 stations was < 33 cm.
- The modeled RMS phase error of all 4 stations was < 35 minutes.
- **OVERALL – all 4 stations passed the criteria for both amplitude and phase.**

Improvements to PCTides

- Based on comments from the OPTEST, several improvements were made to PCTides
  - Output graphics upgraded to “gif” format, for ease of distribution to users
  - Added user capability to include and use high-resolution bathymetry datasets
  - Automated process to move pre-selected stations that were on land into the nearest water point
  - Reduced the number of required user decisions

Summary

- Overall, PCTides performed well during its OPTEST meeting 21 of the 24 statistical criteria.

- July 2002 – PCTides was delivered for use as a relocatable, tidal prediction system to the Systems Integration Division at the Naval Oceanographic Office.